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Optimization of solvothermal liquefaction of water hyacinth over PTFE-acid mediated kaolin catalyst for enhanced biocrude production

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Abstract

The invasive nature of water hyacinth and the need for renewable energy sources have necessitated this research. Catalyst development through enhanced pore structure and process parameters optimization are requirements for effective mass transport during the biomass valorization and improved biocrude formation during solvothermal liquefaction process. In this present study, the effects of temperature (250–340 °C), residence time (10–20 min) and catalyst loading (10–13 wt%) on biocrude, biochar, gas yield, and biomass conversion were optimized using a Box-Behnken experimental design. The developed catalyst through the application of polytetrafluoroethylene (PTFE) for pore structure enhancement was characterized using SEM, BET and XRD techniques. The process optimization found maximum biocrude yield (32.0 wt%), minimum biochar yield (19.4 wt%) and maximum conversion efficiency (80.6%) at 340 °C, 20 min residence time, and 13 wt% catalyst loading. The GC-MS result of the biocrude produced at the optimum conditions (13 wt% catalyst loading) consists of ketones (32.2%), acids (22.3%) and had 65.2% carbon, 7.3% hydrogen, HHV of 29.4 MJ/kg and H/C ratio of 1.34 while an increment in catalyst loading of 20 wt% enhanced the overall biocrude properties with HHV of 35.50 MJ/kg. This result depicts the suitability of the PTFE modified acid treated kaolin for high quality biocrude production through valorization of water hyacinth into a candidate for renewable energy material.